Hot Iron

Issue 13 *"Journal of the Constructors Club"* **Autumn 1996**

Contents

Editorial

As the weather is doing its usual best to disrupt my harvesting activities, I think I had better make a start on this issue of Hot Iron! Much as one would like to be able to think up suitable electronic topics while driving the combine, the best I can do, is to wonder if there is some sort of smoke detector that will react to burning rubber from slipping belts and burning chaff on the exhaust manifold! It took much of yesterday to change one belt! Access for repairs was not a high design priority!

Just recently I have sent follow-up questionnaires to those inquiring about kits who have not actually ordered anything; one answer was noteworthy as the author said he never bought kits where he thought the kit price was higher than the sum of the cost of the individual parts. In my experience, this is nearly always the case because the economies of scale are not great and overheads have to be recovered. A supplier of quality kits has to buy his parts from reputable and repeatable suppliers so that the vagaries of customer's demands can be met without huge unsold stocks of parts costing 8% per annum. While an individual can go to a rally and buy air variable capacitors for 50 pence and a slow motion drive with knob for a £1, they will cost me over £10 even at the 25 off rate. (This is why I stick to varactor diodes and pots!) Costing most parts at the 25 off rate and adding the PCB material, etching and drilling charges, instructions and then those dreaded overheads, means that the kit price is significantly higher than the 'rally' part's costs. What overheads? Advertising (1/16th page in Radcom £75), sales leaflets, phone, stationary and postage not paid by customers, photos of new products, development parts for new product circuit design, PCBs and at least one prototype model, share of capital item costs, (test gear, computer, reference books) etc..! My time - free for fun!

Product News

Readers may recall my mentioning the Drayton CW transmitter as a companion to the Pitney RX; now the ***Martock*** RX is available for those wanting a dedicated amateur band RX to go with the Drayton. Experience has shown that the Drayton will work up to 15 MHz simply by changing the 'crystal' - it is actually supplied with a ceramic resonator for 80m which allows a far wider pulling range (40 KHz) than can be obtained with a crystal. It is almost a VFO!! The ***Martock*** is a direct conversion RX for any single band 20 to 160m by selection of coil/capacitor combinations at ordering. It is equipped with double tuned RF filters, a sharp SSB audio filter and a narrow humped low pass filter for CW centred on 750 Hz. The output stage drives walkman type phones or a small speaker. The VFO has special temperature compensating capacitors to ensure adequate stability at up to 20m but since it is operating at the received frequency, if it were to be used for driving a CW transmitter, there would be severe chirp problems! This is why the companion TX to the Martock is the crystal controlled Drayton TX. For CW on the higher bands with a VFO, you need the ***Frome!***

Design work on the ***Frome*** is progressing well; it is multi-band by single or two band plug-in cards like the Taunton for up to 15m with full VFO coverage on all bands. 5 Watts RF output on CW. Double tuned RF filters and sharp audio filters like those in the Martock. This rig will complete the line of HF TCVRs. The signal generator kit makes slow progress as it has proved very difficult to eliminate the close-in harmonics. I think this is now solved and it only needs the PCB to be laid out again! Tim Walford G3PCJ

Hot Iron is a quarterly newsletter for radio amateurs interested in building equipment. It is published by Tim Walford G3PCJ for members of the **Construction Club**. Articles on simple theory, construction, testing, updates on kits, questions and suggested topics are always wanted. Please send correspondence and membership inquiries to Upton Bridge Farm, Long Sutton, Langport, Somerset, TA10 9NJ. Tel & Fax 01458 241224 The Copyright of all material published in Hot Iron is retained by TRN Walford. ©. Subscriptions are £6 per year for the UK (£8 overseas) from Sept 1st in each year. June 1st 1996.

Pitney Tuning and RF Gain Control

Here are a few optional modifications which make the Pitney more suitable for dedicated amateur band use. The Pitney's frequency coverage can be reduced so that your chosen band(s) fills a larger part of the coarse tuning knob swing, possibly making the fine control unnecessary so that it can be re-used as an RF gain control. Because the Pitney has very little provision for tuning presets, the following alternative capacitor values must be taken as guidance only and may need some adjustment for your particular rig. Obtain these parts at rallies etc.. You may find that switching L2 in and out of circuit, enables you to retain coverage of some parts of 80 and 160m with the same setting for L1 - but generally L1, and maybe C20, will need adjusting for each band if coverage is to be spread over the full pot rotation. If you wish to retain it as a three band rig covering specific segments, you will definitely have to have extra trimmers and switching which are beyond these notes! Extra RX capacitor(s) C20/21 are required for each band to provided the fixed part of the tuning capacity. These are installed on the underside of the PCB between the track leading to RX pad B and the nearest suitable ground track having a chassis symbol, so as to connect them across the main coil of L1 of the RX. The Pitney's original C5 (10 nF disc) should be removed and the RX pad A should be linked to the ground plane.

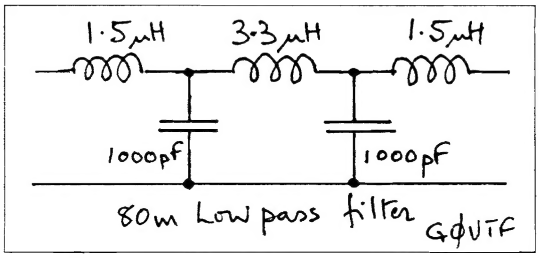
Band	New approx tuning range - KHz	Links to replace original switch connections	New C20	New C21	New C5	New C6
160m	1810 - 1860		100 pF	100 pF	100 pF	56 pF
80m	3540 - 3630	RX pads B to C - perhaps via switch.	100 pF	100 pF	100 pF	56 pF
40m	7000 - 7150	RX pads B to C.	22 pF trimmer		100 pF	15 pF

After making these changes, decide if the fine tuning control is really needed. If not, remove the wires to RV3 and reconnect the slider of RV2 to the RX point TV. The RX track between C2B and the hot end of L3 should be cut in its middle so that the RF gain control can be connected between C2B and L3. The anti clockwise end of RV3 should be connected to the ground plane. The clockwise end of RV3 should be connected to L3. The slider of RV3 should be connected to C2B. RV3 should now act as an RF gain control and will allow the Regeneration control to be left just either side of the point of oscillation for maximum selectivity. Using RV3 as an RF gain control will also help reduce cross modulation from strong unwanted signals. G3PCJ

Coker Modifications

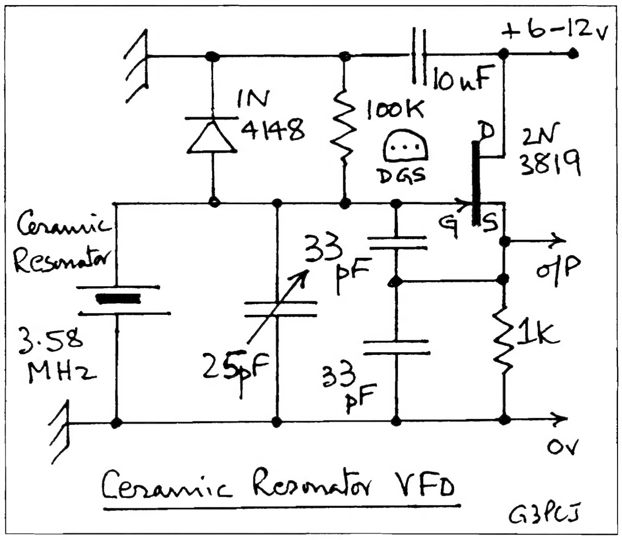
David Proctor, G0UTF, found the following useful:-

1. Add a low pass filter (circuit right) on the output to reduce TVI when using his unbalanced antenna system.
2. Reduced VFO drift by using a silver mica cap for C1.
 (I have a set of alternative capacitor types which cure the drift tendency - please send £1 in stamps if wanted. G3PCJ)
3. Add 1K pot in series with the tuning pot for bandspread.
4. Optional SSB audio response by switching 1K across L3.
5. Use relay contacts to switch in RIT control voltage on receive.



Ceramic Resonator VFO for 80m

The circuit right is that in the Drayton. It is a Collpits oscillator with the resonator instead of a crystal or parallel coil/capacitor combination. The ceramic resonator requires a nominal 30 pF capacity in parallel but by making part of this variable, the frequency can be varied appreciably. A trimmer or air variable can be used (or even a varactor and pot!). The relatively high Q of ceramic resonators means that chirp, due to RF feedback from the transmitter output is unlikely to be so large as to be troublesome. The commonly available 3.58 MHz ceramic resonators can be swung over 40 KHz with a 22 pF trimmer which is just over 1%. The same technique would swing a crystal nearer 0.05%! Although 10 MHz ceramic resonators are available, I could not make mine reach the 30m amateur band! G3PCJ

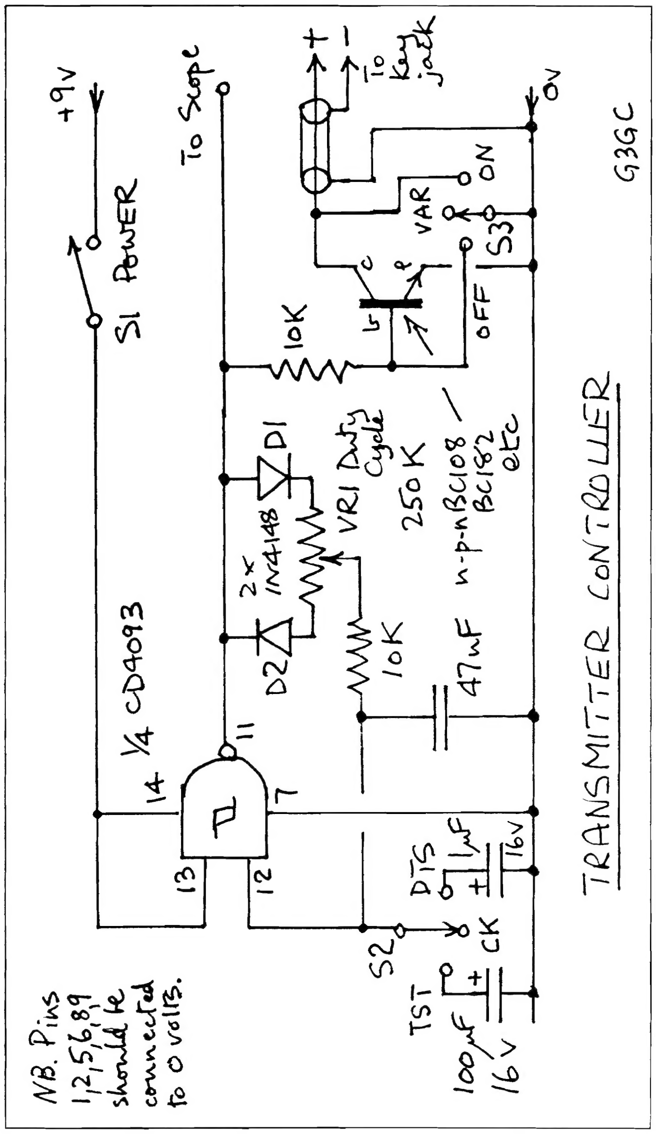


Transmitter Controller by Eric Godfrey G3GC

This device has two main uses with a CW transmitter and saves a lot of hand key operation!

1. Keying the TX with varying duty cycles for soak testing, etc.
2. Generating continuous dots for assessing unwanted effects.

The circuit can be built in a small plastic or metal box using veroboard etc. with its own internal 9 volt battery. The output lead has a jack suited to the key socket of the transmitter under test. The transmitter must be of the type where the key normally switches only low currents with low open circuit voltages. The transmitter RF output should of course be connected to a dummy load or antenna system depending on what is being investigated.



The circuit shown right simply comprises an astable NAND Schmitt trigger connected to an output switching transistor. The jack plug output is taken from the transistor's open collector and 0 volts. The transmitter's key control line should have an open circuit voltage below about 15 volts positive. The repetition frequency (RPF) of the astable is dependent upon the position of S2 which selects one of three capacitors. The position labelled TST gives a low RPF, about 15 Hz, suited to prolonged duty cycle soak testing; the middle position labelled CK gives a high RPF (100 Hz) suited to scope observation of keying characteristics while DTS is used to provide dots at about 17 wpm for identifying transmitter harmonics, intermodulation products and other nasties. The selected capacitor is charged through the 10K resistor and that part of duty cycle pot VR1 connected by D1. It is discharged by the 10K and the other part of the pot connected by D2. When the pot is in mid-position, the charge and discharge times are the same giving a 1:1 mark to space ratio or a 50% duty cycle. The pot alters the charge and discharge times to give duty cycles of up to 5/95% in either direction. The output of the NAND gate (pin 11) is a square edged wave, of amplitude equal to the supply voltage and repetition rate dependent on the setting of S2, with a duty cycle controlled by VR1. This output, which can be used to trigger a scope, drives the output switching transistor which can be practically any n-p-n type. The switch S3 has positions for OFF (no keying action), VARiable with key 'down' duration set by the pot VR1, and ON where the transmitter is producing continuous RF.

Part Location and Screen Printing

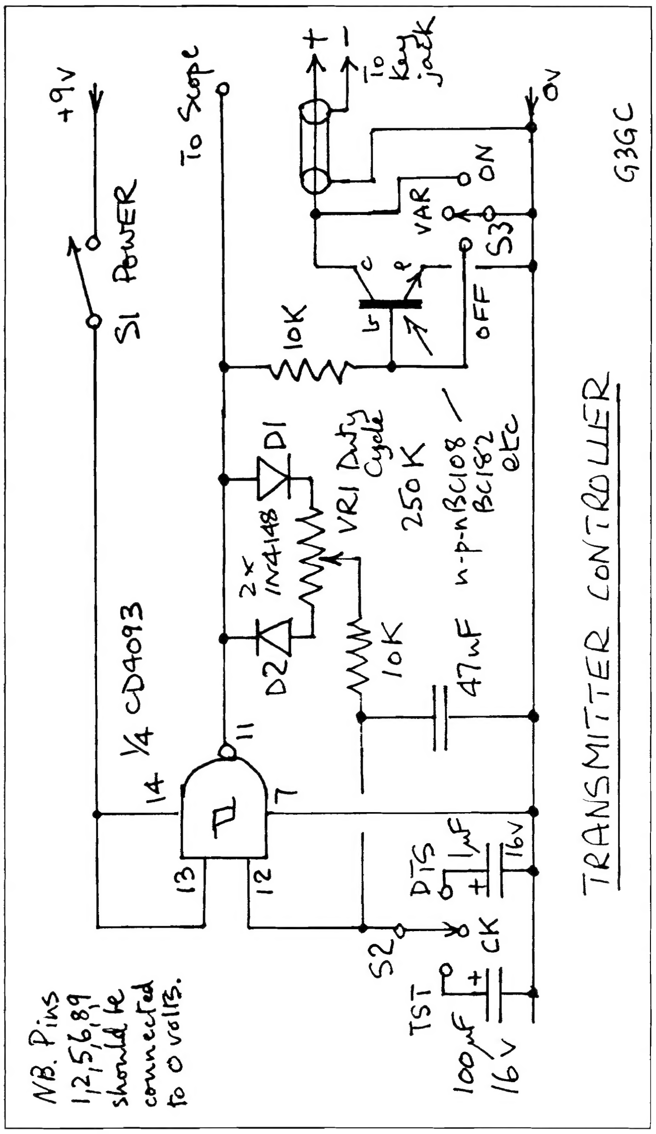
Potential builders often express caution about being able to find the correct holes in a PCB, particularly if their eyesight is not as good as they would wish. I have to admit that I now use a magnifying glass far more often than I would like! I find the markings on certain types of capacitor particularly hard to read. The very large illuminated bench mounted magnifying lenses are highly recommended; with care, one of these lenses should enable most builders to find the correct holes for parts. I do not include screen printing on the PCBs because it is another process that would add to PCB cost and would reduce design flexibility notably on dense boards where often it is essential to mount resistors vertically. While this may require more care by the builder, that is in your time which is free to you! Studying the track layout, checking as parts are inserted, followed by testing in stages greatly helps circuit understanding. The alternative approach of inserting all items from a parts list, applying power and praying it will work is not suited to moderately complex circuits! I try to start construction with the larger parts that can only be put in one way and whose location should be obvious, such as presets and TOKO coils. Another approach is to scribe the top ground plane with fine lines on a 1 cm square grid. On more complex projects I now include a grid reference for all parts based on such a grid. G3PCJ

Transmitter Controller by Eric Godfrey G3GC

This device has two main uses with a CW transmitter and saves a lot of hand key operation!

1. Keying the TX with varying duty cycles for soak testing, etc.
2. Generating continuous dots for assessing unwanted effects.

The circuit can be built in a small plastic or metal box using veroboard etc. with its own internal 9 volt battery. The output lead has a jack suited to the key socket of the transmitter under test. The transmitter must be of the type where the key normally switches only low currents with low open circuit voltages. The transmitter RF output should of course be connected to a dummy load or antenna system depending on what is being investigated.



The circuit shown right simply comprises an astable NAND Schmitt trigger connected to an output switching transistor. The jack plug output is taken from the transistor's open collector and 0 volts. The transmitter's key control line should have an open circuit voltage below about 15 volts positive. The repetition frequency (RPF) of the astable is dependent upon the position of S2 which selects one of three capacitors. The position labelled TST gives a low RPF, about 15 Hz, suited to prolonged duty cycle soak testing; the middle position labelled CK gives a high RPF (100 Hz) suited to scope observation of keying characteristics while DTS is used to provide dots at about 17 wpm for identifying transmitter harmonics, intermodulation products and other nasties. The selected capacitor is charged through the 10K resistor and that part of duty cycle pot VR1 connected by D1. It is discharged by the 10K and the other part of the pot connected by D2. When the pot is in mid-position, the charge and discharge times are the same giving a 1:1 mark to space ratio or a 50% duty cycle. The pot alters the charge and discharge times to give duty cycles of up to 5/95% in either direction. The output of the NAND gate (pin 11) is a square edged wave, of amplitude equal to the supply voltage and repetition rate dependent on the setting of S2, with a duty cycle controlled by VR1. This output, which can be used to trigger a scope, drives the output switching transistor which can be practically any n-p-n type. The switch S3 has positions for OFF (no keying action), VARiable with key 'down' duration set by the pot VR1, and ON where the transmitter is producing continuous RF.

Part Location and Screen Printing

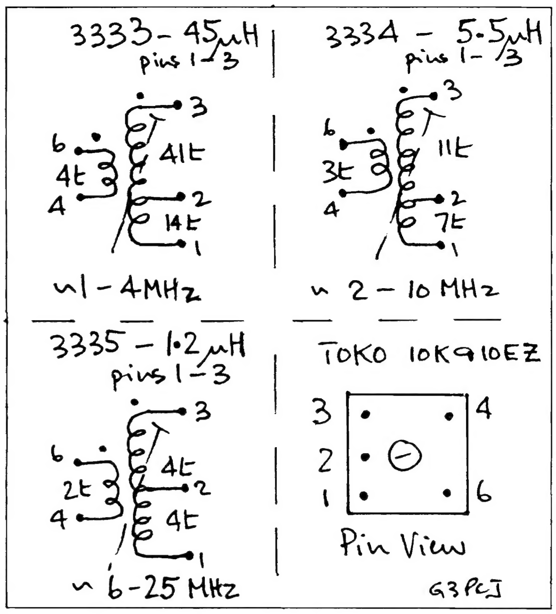
Potential builders often express caution about being able to find the correct holes in a PCB, particularly if their eyesight is not as good as they would wish. I have to admit that I now use a magnifying glass far more often than I would like! I find the markings on certain types of capacitor particularly hard to read. The very large illuminated bench mounted magnifying lenses are highly recommended; with care, one of these lenses should enable most builders to find the correct holes for parts. I do not include screen printing on the PCBs because it is another process that would add to PCB cost and would reduce design flexibility notably on dense boards where often it is essential to mount resistors vertically. While this may require more care by the builder, that is in your time which is free to you! Studying the track layout, checking as parts are inserted, followed by testing in stages greatly helps circuit understanding. The alternative approach of inserting all items from a parts list, applying power and praying it will work is not suited to moderately complex circuits! I try to start construction with the larger parts that can only be put in one way and whose location should be obvious, such as presets and TOKO coils. Another approach is to scribe the top ground plane with fine lines on a 1 cm square grid. On more complex projects I now include a grid reference for all parts based on such a grid. G3PCJ

RF Bandpass Filters

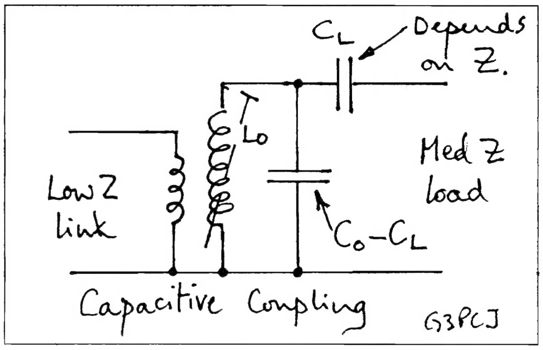
The more common filters are based on parallel tuned circuits, either 'single' tuned with one resonant circuit or 'double' tuned with two coupled resonant circuits. Coupling in and out maybe by transformer coupled link windings or by capacitors. Since people don't like winding any coils, invariably design starts by selection of a standard coil from the TOKO range whose more common parts are shown right. Knowing its inductance, the desired resonating capacitor C_0 is calculated from:-

$$C_0 = \frac{10^6}{(2\pi f)^2 L_0} = \frac{25,330}{L_0 \times f^2}$$

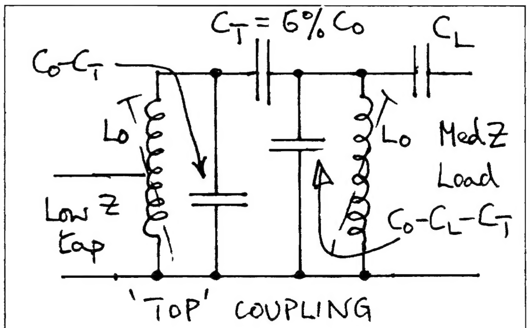
C_0 in pF, f in MHz, L_0 in μH.

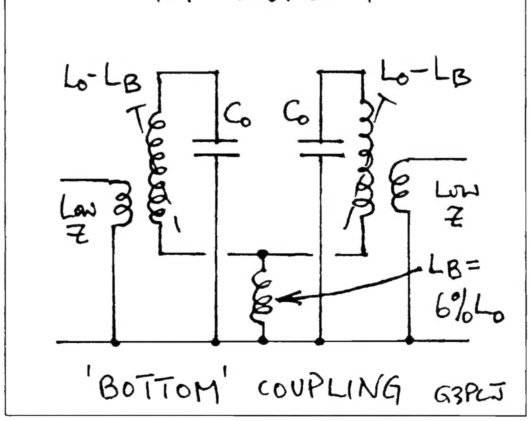


This capacity maybe any combination of fixed and variable types. The parallel part of the circuit operates at high impedance and Q will be reduced if low or medium impedance loads are connected directly across the main L and C. In practical terms, only the high impedance of FET gates should be connected directly across the main resonant windings. Where link windings are used for input/output, the load impedance is multiplied up by the square of the turns ratio between primary and secondary. Generally it is unwise to load the resonant circuit with less than a few KOhms due to these multiplied up in and out impedances. Quite often 50 R in/out impedances, typical of antenna feeders or some interstage couplings, can be connected direct to the link winding. Where capacitive coupling is used to link to the 'hot' end of the resonant circuit, then small capacitors being a fraction of the resonating capacitor C_0 are needed. It is a complex calculation! As a very rough guide, use 10% of C_0 for linking to 50 R, about 25 to 33% C_0 for linking to 300 R and perhaps up to 50 % C_0 for 1K. The actual capacitor required for the main resonating capacitor will have to be reduced by the linking capacitor value. It is unwise to use capacitive coupling for both input and output coupling as this degenerates into a high pass circuit rather than the desired bandpass response.



Where two (or more) resonant circuits are coupled together with the objective of giving higher attenuation away from the passband, then either a small capacitor between the *top* 'hot' ends of the resonant circuits, or small inductors at the *bottom* of the main inductors can be used. See right. The small top coupling capacitors should be about 6% of C_0 for a typical overall Q of 10 which is commonly needed. This value will also have to be deducted from the main resonating capacitors of both inductors. Reducing the linking capacitor will raise Q, while increasing it will lead to a double humped response and a dip at the passband centre frequency. Where the coupling is done by small inductors, the coupling inductor should be about 6% of the main resonating inductance. In an ideal world bottom coupling is preferred since the coupling inductance looks like a short at low frequency which helps preserve the desired bandpass characteristic. However, in practice, top coupling is far more convenient and is the most common technique. The same methods can be used for adding a third resonant circuit for even better stop band rejection. The guidance here is necessarily very approximate; for serious work the best treatise that I have found is in the ARRL Circuit Designers Handbook.. G3PCJ



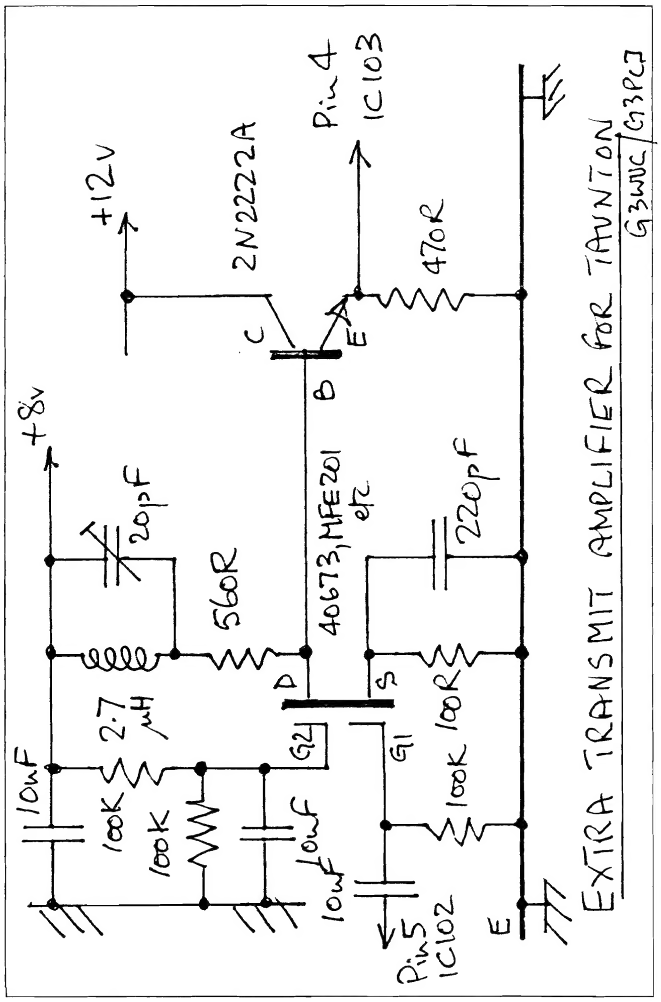


Taunton TCVR on 10 and 12 metres by Rev Tony Measures, G3WUC

Having changed my single band cards to double ones, I have been able to experiment with the singles for 12m and the first section of 10m to 28.5 MHz. The table shows the bandcard parts required - note the change of TOKO coil type for 10m RF BPF and the use of yellow T68-6 cores for the TX matching coil. With the crystals that I had available (14.910 for 12m and 18.0 MHz for 10m), the VFO had to go down to 3.98 MHz and I raised the upper end to 4.515 MHz for extra coverage with my single crystal on 10m. The wider VFO range only needed adjustment of L102 and RT101; although this upsets the normal tuning calibration, it is immaterial if you have a digital readout. (See earlier notes in Hot Iron Issue 12 about crystals for these bands.) Later I hope to fit an extra slide switch and an 18.5 MHz crystal to obtain all of 28.0 to 29.0 MHz. These two cards tune pretty well but more drive is needed to obtain full output, especially on 10m; nevertheless I4KDR did give me 5 &3 when I was only up to 1 Watt! My earlier efforts with an on-card RF amplifier became unnecessary with Tim's suggestion of an extra transmit only amplifier between Mixer and switch (IC102 and IC103). The circuit is essentially a broadband common source amplifier with a gain of 5 followed by an emitter follower to isolate the amplifier drain load from high the capacitance of the following 4066 and longish tracks to the RF filter. The main drain load is the 560R resistor but the 2.7 µH & 20 pF trimmer can be peaked for a little extra output on 10m. The 220 pF bypassing the source resistor also lifts the gain at the HF end. Since it is in the transmit path it does not have to be controlled. It should be installed with short leads etc. on the underside of the main board with the track between pin 5 IC102 and pin 4 IC103 being cut at each end. Because it is in circuit for all bands, it will require a reduction in the drive preset for all existing bands and possibly a tweak to the RF BPFs for the higher frequency bands. As part of my earlier efforts, I had already changed TR303 to a 2N2369A but this may not be necessary and if a 2N2222A is not available for the extra amplifier, it is well worth trying a BC182, BC108 or BC109. After adding these circuits I was able to attain 5 Watts on 12m & 4.4 Watts on 10m using a 13.8 volt supply with a standing current of 0.9 Amps in TR301. Raising the supply to 15 volts produced the target 5 Watts on 10m! (Well done Tony! I hesitate to offer this as a formal kit because I suspect the actual performance may vary appreciably from rig to rig, however it is indicative of what should be possible; if anybody wants assistance with parts etc. please let me know. G3PCJ)

Part No	12m	10m
RF freq	24.94 MHz	28.25 MHz
L201	3335	4613
L202	3335	4613
C201B	10 nF	10 nF
C202	18 pF	6p8
C203	4p7	1p8
C204	22 pF	6p8
C205B	10 nF	10 nF
LO freq	18.94 MHz	22.25 MHz
L203	3335	3335
L204	3335	3335
C206A	15 pF	15 pF
C207	33 pF	33 pF
C208	2p7	1p8
C209	33 pF	33,pF
C210B	10 nF	10 nF
LO xtal	14.91 MHz	18 MHz
C251	65 pF trim	65 pF trim
C252	65 pF trim	65 pF trim
L251	12 t - T68-6	11 t - T68-6
Link 202	Yes -add	Yes -add

C201A, C205A, C206B & C210A not required.

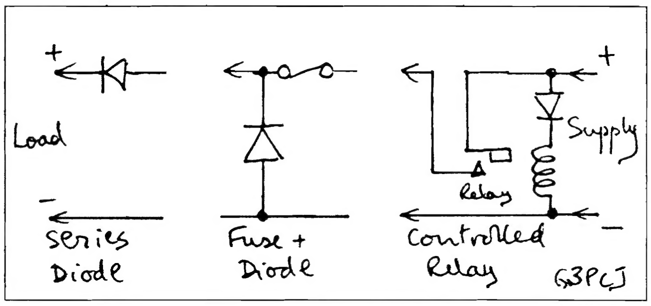


Power Supply Protection

One of our members recently had a cheap CB type commercial PSU fail, resulting in high DC volts on his Taunton plus counter, which burnt out some of the chips supplied direct from the 12 volt line. Hence these notes! These are not complete circuits since you may be able to use what is already in your junk box. It is necessary to keep protection circuits simple so that their reliability will be appreciably higher than the item which might fail, causing damage. However simple circuits often have poorly defined operating points so it is vital to try them out with care on dummy loads first!

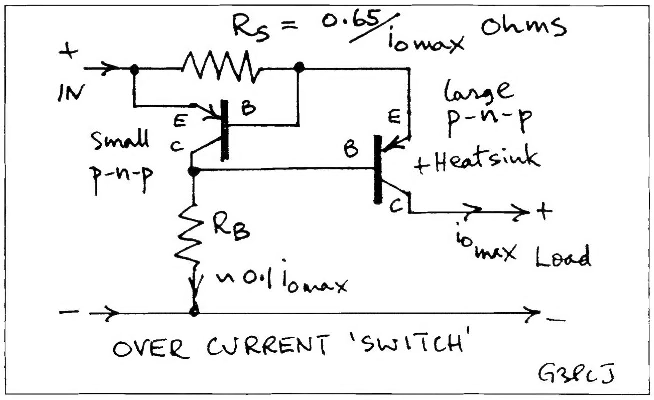
Reverse polarity - protects against operator failure!

The easiest is a series watty diode, better is a series fuse followed by watty diode across the supply. Note that a correctly connected RF output stage FET such as an IRF510 acts just like this power diode (assuming its drain is always connected to the supply). This has saved my Yeovil once with the supply wires acting as fuse! Even better still is a relay with a diode in series with the coil - see right.



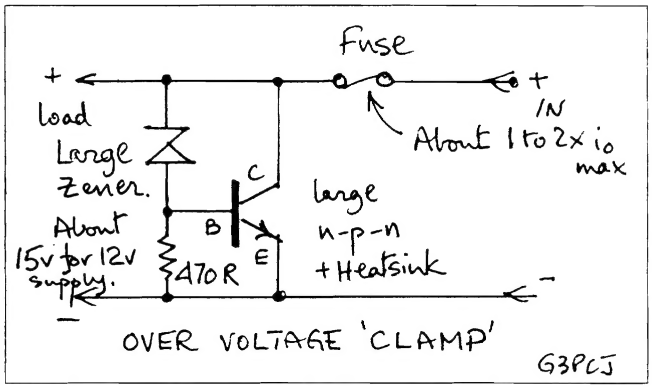
Over-current sensing - protects against load failure!

The load current is sensed and, when above some threshold, shuts down the regulator by removing the control voltage. Most schemes depend on the load current flowing through a resistor which turns on a transistor, hence there is nearly always a voltage drop of about 0.7 volts The 'switch' scheme outlined right can be added to an existing supply but will have a variable loss across it up to about 1 volt. This can be avoided if it is placed in the raw DC line feeding the regulator. The current through R_B needs to be about 10% of I_O max. - also consider R_B dissipation. The sense resistor should be about 0.65 volts divided by I_O max. Use a watty transistor + heatsink for the output.



Over-voltage sensing - protects against PSU failure!

Here a fast acting circuit is needed to avoid damage to the load. Usually the excessive voltage triggers a 'crow-bar' across the supply - often done with an SCR which stays on till the PSU is shut down. The scheme on the right is a compromise between simplicity and precise trip voltage. Again use a watty transistor with heatsink and also a relatively watty zener. Don't forget the fuse or you may loose the protection devices as well! It is well worth trying this out first with a variable power supply to assess the actual voltage at which the transistor turns on hard.



Metalwork!

Yet another case recently of inadequate metalwork acting as heatsink in a PSU; this time with a LM317T regulator which warmed up after a few minutes and began to shutdown by reducing the supply voltage. The consequence was a slow change in VFO frequency as the PSU warmed up. If the regulating device feels hot to touch add more metal! It may be able to handle a high current but only if it is kept cool! G3PCJ

A PLEA!

Help! I am running out of ideas. Please let me know what you want to have covered in Hot Iron. Even better still, write me a few notes. Do not worry about the style etc. as I am quite happy to put it into shape. I can scan in a photo of something interesting if you have one. You won't want my rumblings for ever!

As implied elsewhere, the HF line of rigs in the Somerset Range is nearly complete, so I am thinking about further construction projects; if you do drop me a line, tell me what you would like to build next. Would you like something for 50 or 70 MHz or more test gear, grid-dippers, Hi Z Hi freq probes etc.??? G3PCJ